

Electronics MobileComm U.S.A., Inc. ("LG"), NEC USA, Inc. ("NEC USA"), NEC America, Inc. ("NEC America"), Sagem S.A. ("Sagem"), Sanyo North America Corp. ("Sanyo"), Sendo America Inc. ("Sendo"), Siemens Communications, Inc. ("Siemens"), Sony Ericsson Mobile Communications AB ("Sony Ericsson AB"), Sony Ericsson Mobile Communications (USA) Inc. ("Sony Ericsson USA"), and Spreadtrum Communications Corp. ("Spreadtrum") (collectively "Defendants") and alleges as follows:

I. THE PARTIES

1. The Board of Regents of The University of Texas System is an agency of the executive branch of the State of Texas.

2. Upon information and belief, BenQ is a California corporation having a principal place of business at 53 Discovery, Irvine, California 92618. BenQ is authorized to do business in the State of Texas and may be served with process by serving its registered agent, CT Corporation System, at 350 N. St. Paul Street, Dallas, Texas 75201.

3. Upon information and belief, HTC is a Taiwanese corporation having its principal place of business at No. 23, Hsin Hua Road, Taoyuan, 330, Taiwan, R.O.C. Upon information and belief, HTC is a nonresident of Texas who engages in business in this state, but does not maintain a regular place of business in this state or a designated agent for service of process in this state. Because Taiwan is not a signatory to the Hague Convention, service upon HTC requires service via a letter rogatory in accordance with FED. R. CIV. P. 4(f)(2)(B).

4. Upon information and belief, Innostream is a Korean corporation having its principal place of business at 6th Floor, Daewoo Telecom Building, 265-3, Seohyeon-

dong Bundang-gu, Seongnam-si Gyeonggi-do 463-769, Korea. Upon information and belief, Innostream is a nonresident of Texas who engages in business in this state, but does not maintain a regular place of business in this state or a designated agent for service of process in this state. Innostream may be served with process in Korea pursuant to the Hague Convention on the Service Abroad of Judicial and Extrajudicial Documents.

5. Upon information and belief, Kyocera is a Delaware corporation having a principal place of business at 10300 Campus Point Drive, San Diego, California 92121. Kyocera is authorized to do business in the State of Texas and may be served with process by serving its registered agent, Corporation Services Co. d/b/a Lawyers Incorporating Service Co., at 701 Brazos, Suite 1050, Austin, Texas 78701.

6. Upon information and belief, LG is a California corporation having a principal place of business at 10225 Willow Creek Road, San Diego, California 92131. Upon information and belief, LG is a nonresident of Texas who engages in business in this state, but does not maintain a regular place of business in this state or a designated agent for service of process in this state. This proceeding arises, in part, out of business done in this state. Accordingly, pursuant to TEX. CIV. PRAC. & REM. CODE §§ 17.044 and 17.045, the Secretary of State is an agent for service of process upon LG that may be served with process by serving Geoffrey S. Connor, Secretary of State of Texas, State Capitol Room 1E.8, Austin, Texas 78701, who shall then immediately mail a copy of the process by registered mail or by certified mail, return receipt requested, to LG's home office at 10225 Willow Creek Road, San Diego, California, 92131.

7. Upon information and belief, NEC USA is a Delaware corporation having a principal place of business at 8 Corporate Center Drive, Melville, New York, 11747.

NEC USA is authorized to do business in the State of Texas and may be served with process by serving its registered agent, Prentice-Hall Corp., at 701 Brazos Street, Suite 1050, Austin, Texas 78701.

8. Upon information and belief, NEC America is a New York corporation having a principal place of business at 6555 North State Highway 161, Irving, Texas 75039. NEC America is authorized to do business in the State of Texas and may be served with process by serving its registered agent, Corporation Services Co., at 701 Brazos Street, Suite 1050, Austin, Texas 78701.

9. Upon information and belief, Sagem is a French corporation having its principal place of business at Le Ponant de Paris, 27, rue Leblanc, 75512 Paris Cedex 15, France. Upon information and belief, Sagem is a nonresident of Texas who engages in business in this state, but does not maintain a regular place of business in this state or a designated agent for service of process in this state. Sagem may be served with process in France pursuant to the Hague Convention on the Service Abroad of Judicial and Extrajudicial Documents.

10. Upon information and belief, Sanyo is a Delaware corporation having a principal place of business at 2055 Sanyo Avenue, San Diego, California 92154. Sanyo is authorized to do business in the State of Texas and may be served with process by serving its registered agent, Prentice Hall Corp System, at 701 Brazos Street, Suite 1050, Austin, Texas 78701.

11. Upon information and belief, Sendo is a Delaware corporation having a principal place of business at 909 E. Las Colinas Blvd., Suite 1950, Irving, Texas 75039. Sendo is authorized to do business in the State of Texas and may be served with process

by serving its registered agent, Thomas G. Christian, at 909 Lake Carolum Parkway, Suite 1950, Irving, Texas 75039.

12. Upon information and belief, Siemens is a Delaware corporation having a principal place of business at 900 Broken Sound Parkway, Boca Raton, Florida 33487. Siemens is authorized to do business in the State of Texas and may be served with process by serving its registered agent, CT Corporation System, at 350 N. St. Paul Street, Dallas, Texas 75201.

13. Upon information and belief, Sony Ericsson AB is a Swedish corporation having a principal place of business at 202 Hammersmith Road, London W67DN, United Kingdom. Upon information and belief, Sony Ericsson AB is a nonresident of Texas who engages in business in this state, but does not maintain a regular place of business in this state or a designated agent for service of process in this state. Sony Ericsson AB may be served with process in the United Kingdom or Sweden, pursuant to the Hague Convention on the Service Abroad of Judicial and Extrajudicial Documents.

14. Upon information and belief, Sony Ericsson USA is a Delaware corporation having a principal place of business at 7001 Development Drive, Research Triangle Park, North Carolina 27709. Sony Ericsson USA is authorized to do business in the State of Texas and may be served with process by serving its registered agent, National Registered Agents, Inc., at 1614 Sidney Baker Street, Kerrville, Texas 78028.

15. Upon information and belief, Spreadtrum is a California corporation having its principal place of business at 810 East Argues Avenue, Sunnyvale, California 94085. Upon information and belief, Spreadtrum is a nonresident of Texas who engages in business in this state, but does not maintain a regular place of business in this state or a

designated agent for service of process in this state. This proceeding arises, in part, out of business done in this state. Accordingly, pursuant to TEX. CIV. PRAC. & REM. CODE §§ 17.044 and 17.045, the Secretary of State is an agent for service of process upon Spreadtrum that may be served with process by serving Geoffrey S. Connor, Secretary of State of Texas, State Capitol Room 1E.8, Austin, Texas 78701, who shall then immediately mail a copy of the process by registered mail or by certified mail, return receipt requested, to Spreadtrum's home office at 810 East Argues Avenue, Sunnyvale, California, 94085.

II. JURISDICTION AND VENUE

16. This action arises under the patent laws of the United States, Title 35 of the United States Code. The Court's jurisdiction over this action is proper under the above statutes, including 35 U.S.C. § 271 *et seq.* and 28 U.S.C. §§ 1331 and 1338(a).

17. Personal jurisdiction exists generally over the Defendants because they have sufficient minimum contacts with the forum as a result of business conducted within the State of Texas and within the Western District of Texas. Personal jurisdiction also exists specifically over the Defendants because of their conduct in making, using, selling, offering to sell, and/or importing infringing products within the State of Texas and within the Western District of Texas.

18. Venue is proper in this Court under 28 U.S.C. §§ 1391(b), (c), and (d), as well as 28 U.S.C. § 1400(b).

III. PATENT INFRINGEMENT

19. Plaintiff repeats and realleges the allegations in paragraphs 1-18 as though fully set forth herein.

20. Plaintiff, Board of Regents of The University of Texas System is the patentee and owner of all rights, title, and interest in and under United States Patent No. 4,674,112 ("the '112 Patent"), which duly and legally issued on June 16, 1987.

21. The '112 Patent is for an invention titled "Character Pattern Recognition and Communications Apparatus." A true and correct copy of the '112 Patent is attached hereto as Exhibit A.

22. The '112 Patent is valid and enforceable.

23. Upon information and belief, BenQ has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "S670C" and "S660C."

24. Upon information and belief, HTC has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "SPV E100," "SPV E200," "SDA" and "Canary SPV."

25. Upon information and belief, Innostream has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "INNO 30," "INNO 55," "INNO 89," "INNO 90" and "INNO 98/99."

26. Upon information and belief, Kyocera has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United

States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "Koi/KX2," "SE44," "SE47," "KX1," "K4130," "S14," "5135," "K493LC," "K494LC," "K494NC," "K494XLC," "K404," "K484LC," "K484NC," "K484XLC," "K484XNC," "K7," "K9," "K433L," "KE433," "KE433C," "KX434," "KE413," "KE414," "KX414," "3035," "3250" and "2325."

27. Upon information and belief, Kyocera infringed the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "2345" and "2255."

28. Upon information and belief, LG has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "VX7000," "VX6000," "VX3200," "VI-5225," "PM325," "VX6100," "VX4600," "VX4500," "VX3100," "C1300," "L1150," "G4015," "L1200," "G4050," "G4011" and "G4010."

29. Upon information and belief, NEC USA and NEC America have been and are infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "515 HDM" and "525 HDM."

30. Upon information and belief, Sagem has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United

States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "myX-2" and "myS-7."

31. Upon information and belief, Sanyo has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "MM-7400," "PM-8200," "RL-4920," "SCP-5400," "SCP-5500" and "SCP-7300."

32. Upon information and belief, Sanyo infringed the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "SCP-7200," "SCP-5300," "SCP-4900," "SCP-8100," "SCP-6400," "SCP-6200" and "SCP-6000."

33. Upon information and belief, Sendo infringed the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the product known as "S251."

34. Upon information and belief, Siemens has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "CT66," "S66," "CF62T," "SX1," "C56," "CT56," "S56," "SL56," "A56i" and "M46."

35. Upon information and belief, Sony Ericsson AB and Sony Ericsson USA have been and are infringing the '112 Patent by making, using, selling, offering for sale,

and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the products known as "P910a," "S710a," "Z500a," "T290," "S700i," "K500i," "T237," "T637," "Z200," "Z600," "P900," "T630," "T226," "T610," "T316" and "T306."

36. Upon information and belief, Spreadtrum has been and is infringing the '112 Patent by making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, including but not limited to the product known as "SP7100A."

37. By making, using, selling, offering for sale, and/or importing in or into the United States, without authority, products that fall within the scope of the claims of the '112 Patent, Defendants have also induced infringement of the '112 Patent under 35 U.S.C. § 271(b), and have contributed to the infringement of the '112 Patent under 35 U.S.C. § 271(c). The infringing products have no substantial non-infringing uses.

38. As a direct and proximate result of Defendants' acts of patent infringement, Plaintiff has been and continues to be injured and has sustained and will continue to sustain substantial damages in an amount not presently known.

39. Plaintiff has no adequate remedy at law against these acts of patent infringement. Unless Defendants are preliminarily and permanently enjoined from their infringement of the '112 Patent, Plaintiff will suffer irreparable harm.

IV. PRAYER FOR RELIEF

Plaintiff, Board of Regents of The University of Texas System, respectfully requests that judgment be entered in its favor and against Defendants and that the Court grant the following relief to Plaintiff:

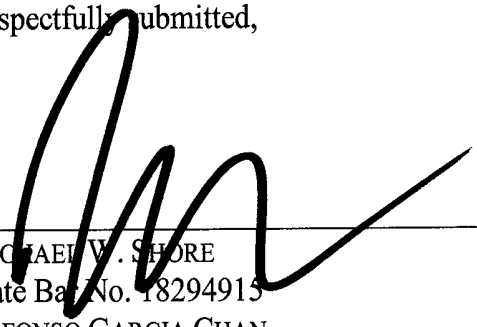
- A. Declare that the '112 Patent is valid and enforceable;
- B. Declare that Defendants have infringed the '112 Patent;
- C. Award damages to Plaintiff to which it is entitled for patent infringement;
- D. Enter a preliminary and thereafter a permanent injunction against Defendants' direct infringement of the '112 Patent;
- E. Enter a preliminary and thereafter a permanent injunction against Defendants' active inducements of infringement and/or contributory infringements of the '112 Patent by others;
- F. Award interest on Plaintiff's damages; and
- G. Such other relief as the Court deems just and proper.

V. JURY DEMAND

In accordance with FED. R. CIV. P. 38 and 39, Plaintiff asserts its rights under the Seventh Amendment of the United States Constitution and demands a trial by jury on all issues so triable.

Dated: March 11, 2005

Respectfully submitted,



MICHAEL W. SHORE
State Bar No. 18294915
ALFONSO GARCIA CHAN
State Bar No. 24012408
RICK H. ROSENBLUM
State Bar No. 17276100
AKIN GUMP STRAUSS HAUER & FELD LLP
1700 Pacific Avenue, Suite 4100
Dallas, Texas 75201
tel. 214.969.2800
fax 214.969.4343

ATTORNEYS FOR PLAINTIFF
BOARD OF REGENTS OF THE
UNIVERSITY OF TEXAS SYSTEM

STEVEN R. COLLINS
State Bar No. 04618300
BARRY D. BURGDORF
State Bar No. 03376500
THE UNIVERSITY OF TEXAS SYSTEM,
OFFICE OF GENERAL COUNSEL
201 West 7th Street
Austin, Texas 78701
tel. 512.499.4462
fax. 512.499.4523

OF COUNSEL FOR PLAINTIFF
BOARD OF REGENTS OF THE
UNIVERSITY OF TEXAS SYSTEM

EXHIBIT A

United States Patent [19]**Kondraske et al.**[11] **Patent Number:** **4,674,112**[45] **Date of Patent:** **Jun. 16, 1987**[54] **CHARACTER PATTERN RECOGNITION AND COMMUNICATIONS APPARATUS**[75] **Inventors:** George V. Kondraske, Arlington; Adnan Shennib, Lake Jackson, both of Tex.[73] **Assignee:** Board of Regents, The University of Texas System, Austin, Tex.[21] **Appl. No.:** 773,371[22] **Filed:** Sep. 6, 1985[51] **Int. Cl.⁴** H04M 11/00[52] **U.S. Cl.** 379/96; 379/97[58] **Field of Search** 179/2 A, 2 DP, 6.11; 340/825.48, 825.74; 379/52, 77, 93, 96, 97, 105[56] **References Cited****U.S. PATENT DOCUMENTS**

4,307,266 12/1981 Messina 179/2 DP

4,578,540 3/1986 Borg et al. .

4,608,460 8/1986 Carter et al. .

4,633,041 12/1986 Boivie et al. .

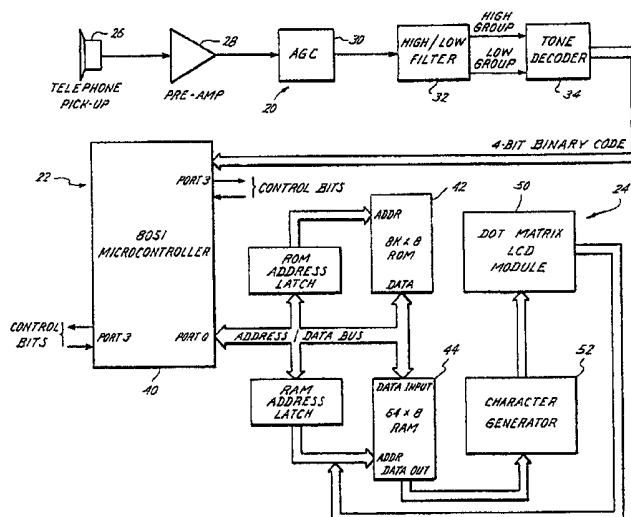
OTHER PUBLICATIONS

Rabiner et al., "Digital Techniques for Computer Voice Response: Implementations and Applications", *Proceedings of the IEEE*, vol. 64, No. 4, Apr. 1976, pp. 416-433.

Smith et al., "Alphabetic Data Entry Via the Touch-Tone Pad: A Comment", *Human Factors*, vol. 13(2), Apr. 1971, pp. 189-190.

Primary Examiner—Keith E. George*Attorney, Agent, or Firm*—Arnold, White & Durkee[57] **ABSTRACT**

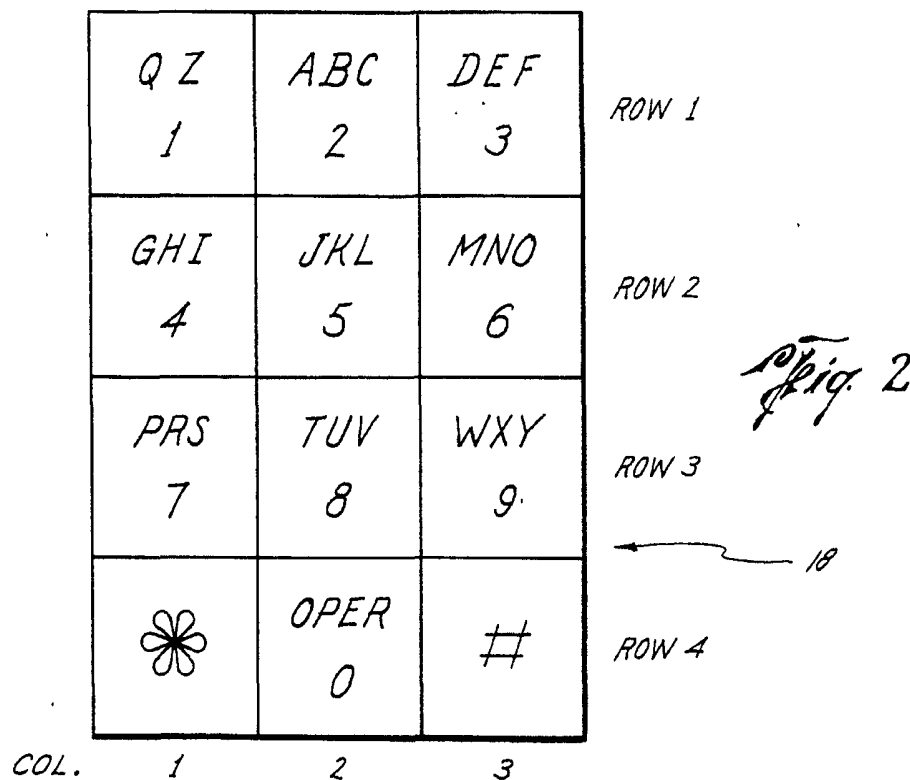
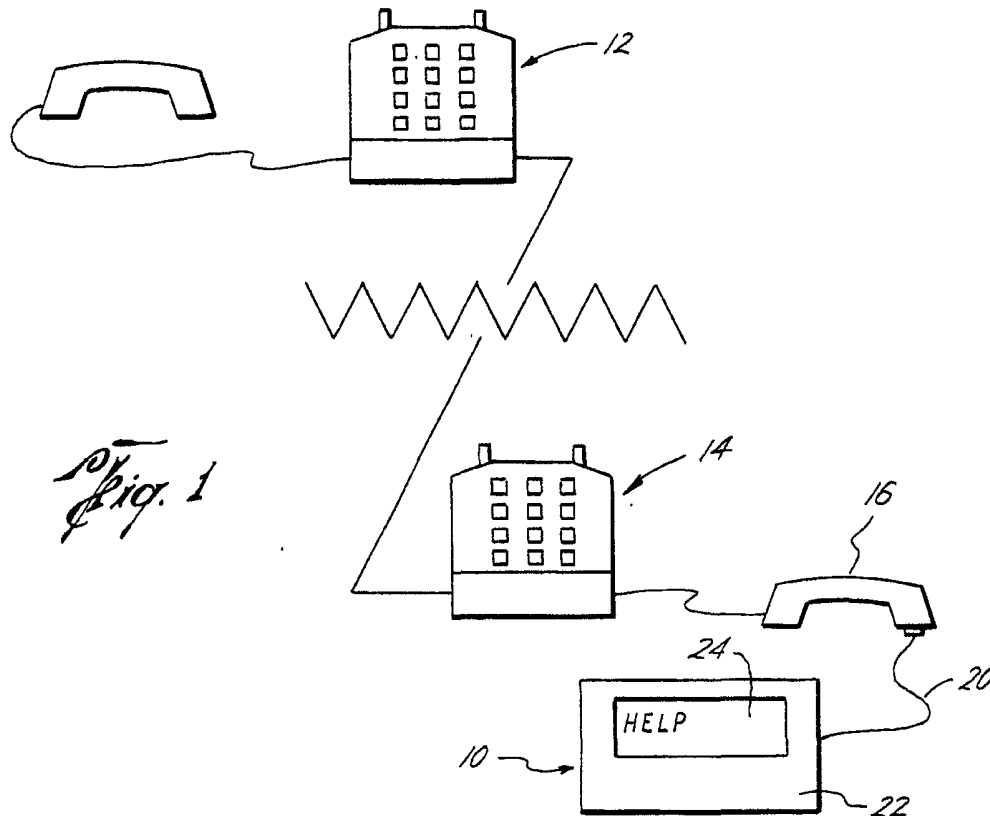
A communication apparatus and method designed to interface with a standard, twelve key, dual tone, multiple frequency telephone, which allows easy, non-verbal entry of a message. Although particularly designed for use by the hearing and/or speech impaired with a dual tone telephone, the apparatus is equally adapted for use with practically any communication network where a keyboard with a limited number of keys is utilized and ambiguity resolution necessary. Generally speaking, the apparatus is connected to the earpiece of a receiving telephone and includes a tone pickup and decoder, a pre-programmed microcomputer and a message display panel. The message sender depresses a single key which corresponds to the alphabetic letter in the word being sent - because most keys on a telephone represent three letters, such a word is ambiguous when sent. The apparatus receives the ambiguous word and resolves the ambiguity in favor of a preprogrammed word which is displayed to the person receiving the message. Although the apparatus can be programmed to recognize words, the apparatus is programmed with a vocabulary of syllabic elements which are used to reconstruct the word. This approach enables an expanded word recognition capability while minimizing memory requirements.

14 Claims, 8 Drawing Figures

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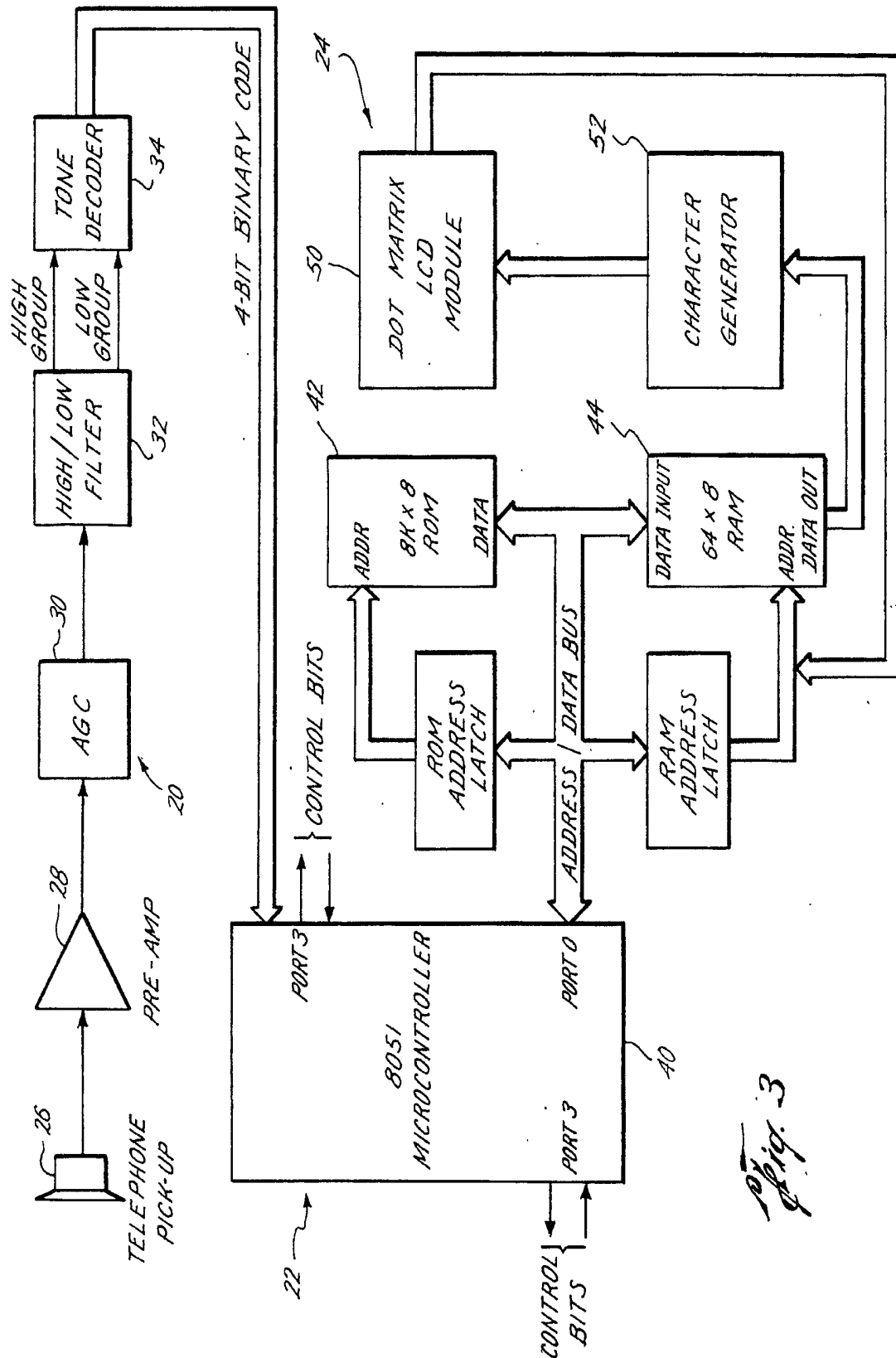
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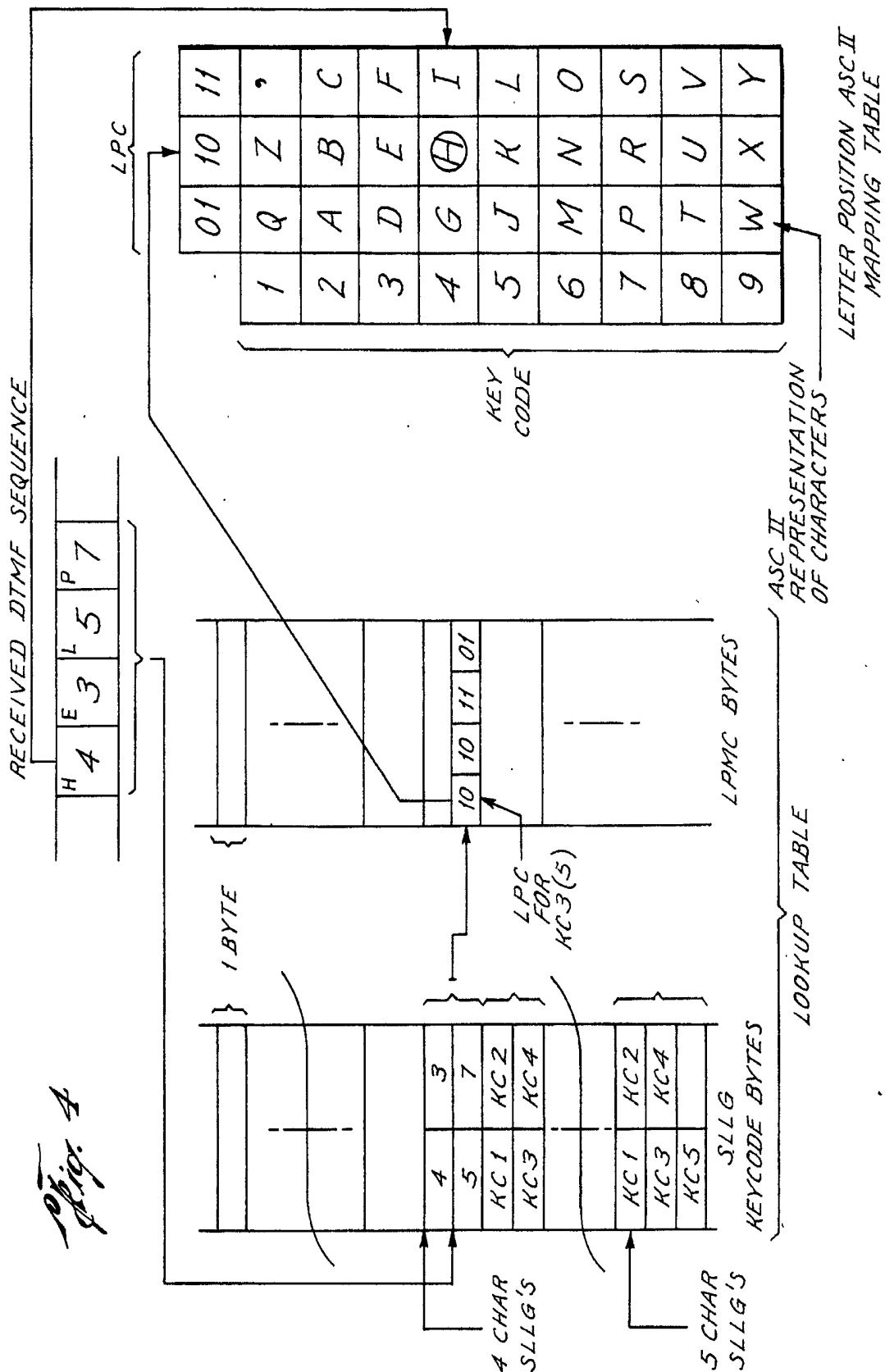
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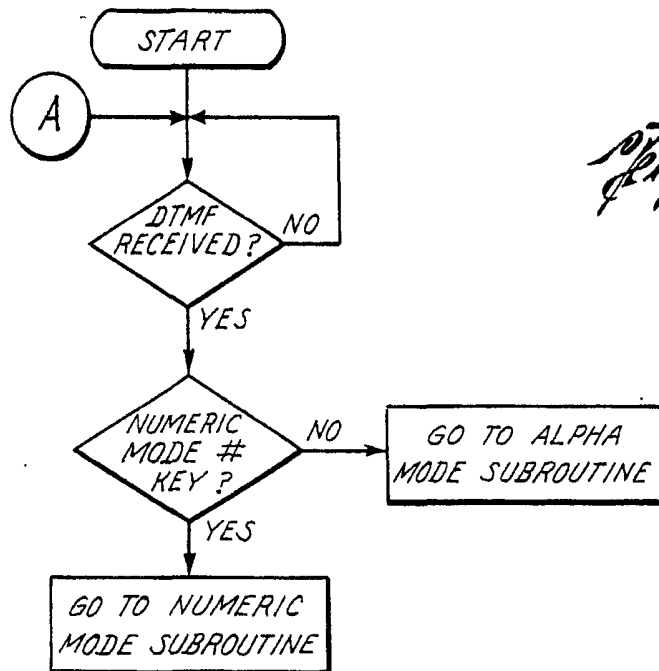
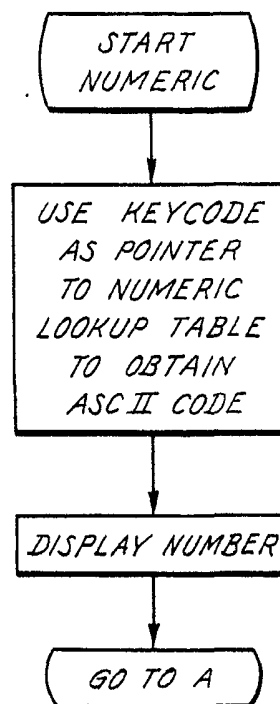
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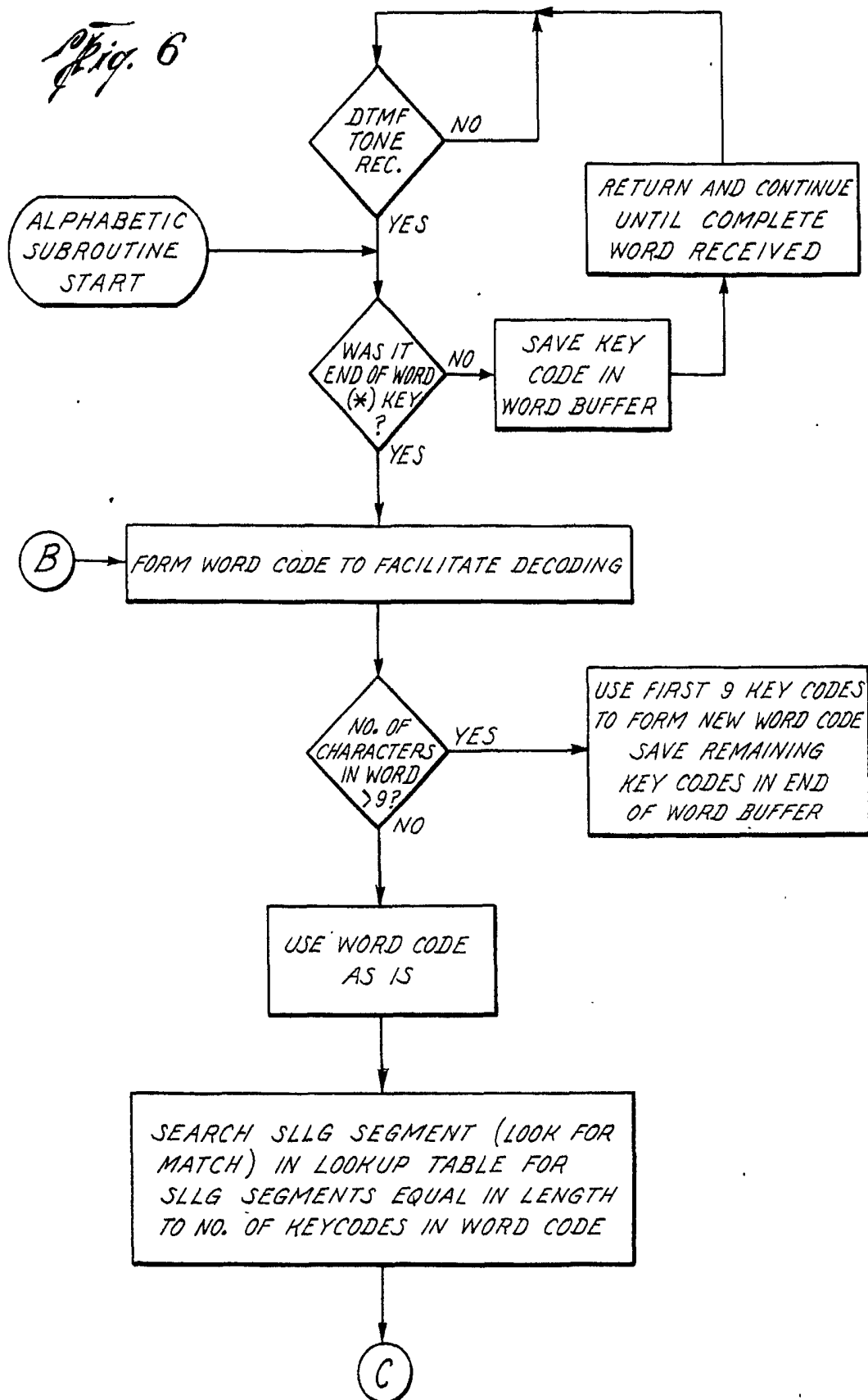
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*Fig. 8*

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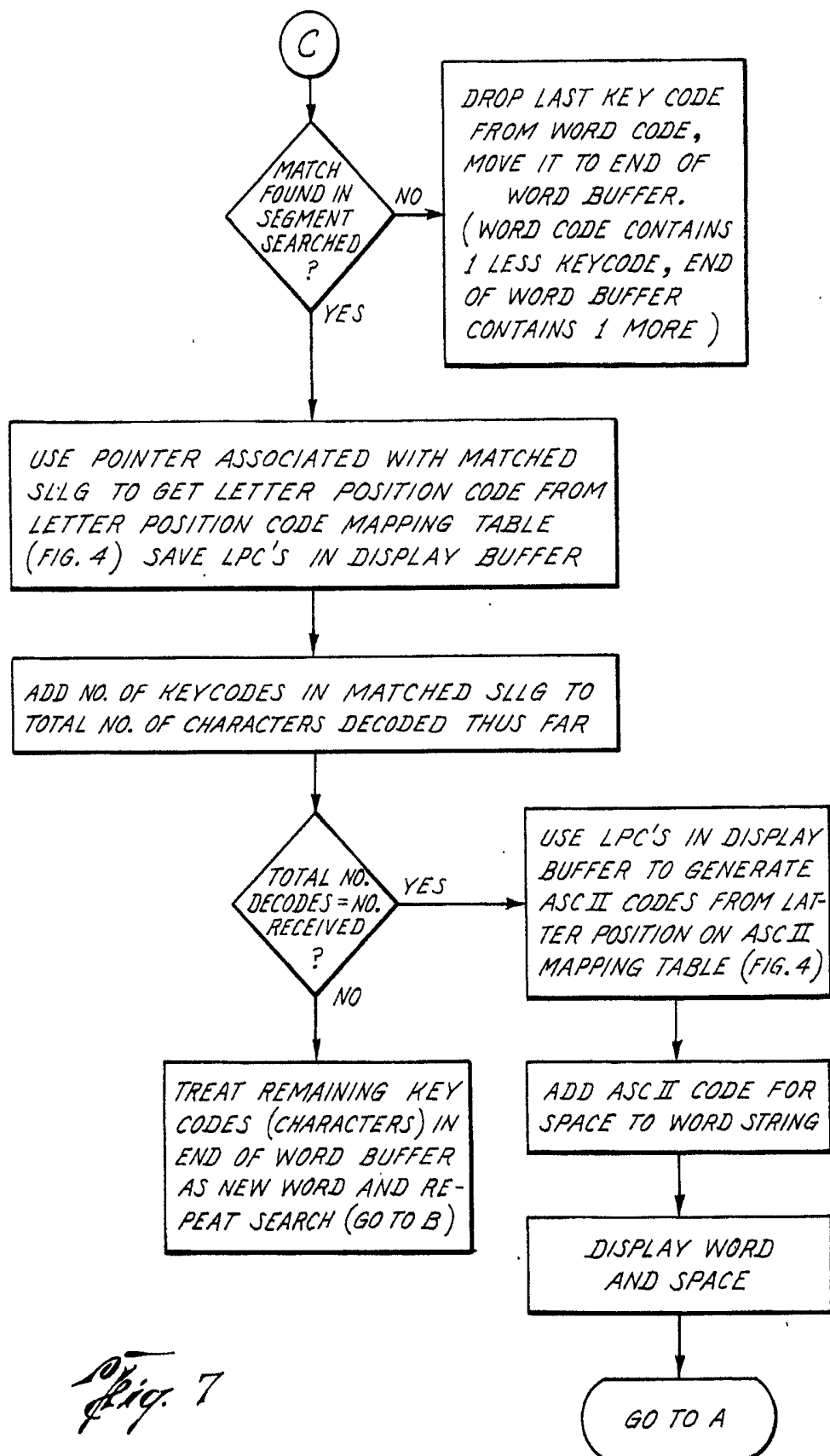
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CHARACTER PATTERN RECOGNITION AND COMMUNICATIONS APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus and method for communicating by manual entry on a keypad using a minimum of key stroke entries. More particularly, the invention relates to an apparatus and method for use by the hearing or speech impaired to communicate over the telephone network using a standard twelve key, dual tone, multi-frequency telephone.

2. Description of the Prior Art

For the hearing or speech impaired to effectively communicate over a long distance, several methods have been devised which enable nonverbal communication over a communications network, such as a telephone grid. Such devices include relatively expensive and nonportable radio teletype terminals and communications-adapted computer terminals. Such terminal keyboards typically employ a standard "QWERTY" keyboard which enables the passage of messages by simply typing in the entire message. Such terminals are, of course, deficient in that they are not only expensive, but also are bulky and difficult to transport.

It has been recognized that it is desirable to use a standard 12 key, dual tone multiple frequency (DTMF or Touch-tone) telephone to communicate between the hearing or speech impaired. Utilizing such a standard "Touch-tone" telephone would be inexpensive and provide a partial solution to the problem of transporting bulky communication equipment. A primary difficulty with using such "Touch-tone" telephones is that the industry standard telephone keypad utilizes 12 keys. Ten of the keys represent a single numeric character, while 8 of the keys each represent 3 alphabetic characters.

To utilize such a standard "Touch-tone" telephone for nonverbal communication, past solutions have used multiple keystroke entries to identify a particular alphabetic letter. For example, a first depression identifies which key the desired letter appears on and a second depression identifies which letter of the three possibilities is desired for input.

The necessity for depressing two keys to identify one letter, is of course a major impediment to effective telecommunication using a standard "Touch-tone" telephone. That is, even short messages require a large number of keystrokes to enter the message.

SUMMARY OF THE INVENTION

The problems outlined above are in large measure solved by the communications apparatus and character pattern recognition method of the present invention. That is, the method and apparatus hereof provides for a single keystroke to identify which alphabetic character is desired. Because each keystroke can represent three possibilities, each keystroke transmitted—and therefore the composite word—is inherently ambiguous. The apparatus hereof receives the ambiguous word and reconstructs and displays the word based upon a preprogrammed ambiguity resolution. To simplify operation and memory size, the apparatus recognizes a particular word in terms of syllabic elements. The syllabic elements can comprise any number of alphabetic characters (for example, from 1 to 9 alphabetic characters).

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Generally speaking, the apparatus hereof includes a receiving mechanism coupled to a telephone which receives a series of transmitted tones corresponding to an inputted word. With a standard "Touch-tone" telephone, each tone received by the receiving mechanism represents three possible alphabetic characters. The receiving mechanism translates each tone into a code—a series of codes corresponding to a word. A controller receives the series of codes and outputs a signal indicative of a particular word which corresponds to the series of codes. The controller advantageously has a recognition means which matches the series of codes received with a programmed code sequence indicative of the particular word. Once the particular word is identified, a signal representative of the particular word is passed to an indicating means which displays the word to the receiving person.

Preferably, the receiving mechanism amplifies the ambiguous tone and decodes the tone into binary code. The binary code is passed to the controller which is preferably a preprogrammed microcomputer. The microcomputer fetches the word or syllabic element vocabulary from memory and begins comparing the binary code with the vocabulary. The controller constructs a particular word corresponding to the received binary code and generates a signal to the indicating mechanism representative of that particular word.

Preferably, the indicating means comprises a liquid crystal diode display which visually represents the word or message to the user. In another embodiment, a speech synthesizer audibly communicates the word or message to the user.

The preferred communication method of the present invention contemplates inputting a word or series of words into a standard "Touch-tone" telephone keyboard by depressing a single key for each alphabetic character of the word. The characters are thus transmitted as a series of tones which are decoded by the apparatus hereof into a binary code. The binary code is matched with a preprogrammed vocabulary code representative of an alphabetic character string, such as a word or syllabic element. The word is then output to the receiving person. Although the preferred embodiment anticipates using the apparatus hereof as a receiving unit, it will be appreciated that the apparatus can be easily modified within the scope of the present invention to act as a transmission unit. For example, the apparatus can be modified to utilize a speech synthesizer, with the message sender inputting a word or a series of words into the telephone with the apparatus converting the input into an audible message.

Another important alternative is to utilize the apparatus and method for other modes of communication. For example, the apparatus and method hereof can be incorporated into a paging system network, radio telephone network, or practically any communications network where ambiguity resolution is necessary because of limited keystroke inputs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a typical transmitting and receiving telephone to which the apparatus hereof is operably connected;

FIG. 2 is a plan layout of a dual tone, multiple frequency, twelve key telephone keyboard;

FIG. 3 is a block diagram of the system components of the apparatus hereof;

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FIG. 4 is a schematic representation of the look-up table and ASCII mapping table utilized by the present invention; and

FIGS. 5-8 are flow-charts illustrative of the software utilized in the apparatus of the present invention, where-

FIG. 5 is a flowchart of the main program for determining whether a numeric or alphabetic character is input,

FIGS. 6 and 7 depict the alphabetic subroutine, FIG. 8 illustrates the numeric subroutine.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to the drawings, a communications apparatus 10 is illustrated in FIG. 1 in conjunction with a telephone network having a sending telephone 12 and receiving telephone 14. Each telephone 12, 14 has a hand piece 16 and a twelve key "Touch-tone" key pad 18. Each telephone 12, 14 represents a common, industry standard touch tone system in which a key closure generates two tones according to the dual tone multiple frequency standard. As can be seen from FIG. 2, the standard industry key pad 18 presents twelve keys containing alphabetic and numeric characters, as well as the asterisk (*) and number ("#") characters. FIG. 2 differs slightly from the industry standard in that in a standard touch tone telephone, the alphabetic characters "Q" and "Z" are omitted. In FIG. 2, the letters "Q" and "Z" are carried by the key representative of numeral "1".

Comparing FIGS. 1 and 3, the communications apparatus 10 is shown in more detail. Broadly speaking (see FIG. 1), the apparatus 10 includes receiving means 20, controller means 22, and indicating means 24. In more detail, the receiving means 20 includes an inductive pick-up 26 attachable to the ear portion of the hand piece 16 by a suction cup. In the preferred embodiment, a preamp 28 provides a fixed gain of 60 dB to the automatic gain control amplifier 30. The automatic gain control amplifier 30 has a gain range of 0.1-20 dB resulting in a total gain for the amplifier section (28,30) in the range of 30-100 dB. The output of the automatic gain control (1.5 volts p-p) is fed to a filter section 32 (AMI S3525A intergraded circuit) to separate the high and low dual tone multiple frequency bands. As shown in FIG. 6, the high and low group filter outputs are fed to a tone decoder 34 (e.g., Mostek MK-5102). The tone decoder 34 provides a four-bit binary code to the controller means 22 for each signal received at its input.

The controller means 22 preferably incorporates a microcomputer (Intel 8051) with on-chip RAM and ROM. In FIG. 3, the controller means 22 is illustrated somewhat schematically and depicts the microcomputer 40, ROM 42 (preferably 8K byte EPROM) and 64 bytes \times 8 RAM 44. Preferably, the programed vocabulary is stored on the ROM 42 with the RAM 44 used to store word codes as received, thus providing a buffer to the indicating means 24.

Preferably, the indicating means 24 includes a liquid crystal diode (LCD) display 50 capable of displaying two rows of alpha numeric characters of twenty characters per row. A character generator 52 is coupled to the RAM 44 and the LCD display 50 to generate standard dot matrix characters on the display 50. The LCD display 50 also addresses the RAM 44 to periodically scan ASCII character data in the RAM 44.

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Software

FIGS. 4-8 generally refer to the implementation of the recognition process employed by the controller means 22. FIG. 4 illustrates an example of a recognition search initiated in a segmented look-up table (left-hand portion of FIG. 4). The right-hand portion of FIG. 4 illustrates the ASCII mapping table where the ASCII code for the proper character is stored and fetched for each alpha numeric character. It should be apparent that use of the mapping table results in a considerable memory saving over the alternative of storing complete ASCII strings in memory. FIGS. 5-8 illustrate the flow-charts for the operating programs. The flow-charts are self explanatory. The operation of the lookup table and ASCII mapping table is readily apparent from a comparison of FIGS. 4 and 6-7.

Operation

The initial problem addressed by the present invention was to provide a simple method for the hearing or speech impaired to communicate using standard "Touch-tone" telephones without the need for complicated equipment, such as teletypes, etc. Several devices and methods have been devised which allow for effective communication, but are slow and difficult to use; a large number of keystrokes are involved in inputting a message. As can be seen from FIG. 2, most keys represent three alphabetic letters. Therefore, in the past, a single letter has been input using two keystrokes. For example, to input the alphabetic letter "H" in the word "HELP", the Operator would first push the number "4" key (row 2 column 1) followed by the "0" key (row 4, column 2) to designate the second character on the number "4" key.

In a broad sense, the present invention recognizes the possibility of using a microprocessor-based device to enable a single keystroke per alphabetic letter. That is, it has been found that most English words are identified by the keystroke sequence required to enter the letters of the word—a character pattern recognition. Of course, the invention is equally applicable to the identification of words in other languages as well.

For example, to enter the word "HELP" the numbered keys "4, 3, 5, and 7" are depressed followed by a "*". The "*" key is used to delineate the end of a word. The term "word code" is used to denote the key sequence for a particular word; that is "4357" is the word code for the word "HELP." Of the 3⁴ possibilities (3 characters on each key, four keys to enter the word), there is only one English word—"HELP"—from the 3⁴ possibilities involved.

Because each key on a standard "Touch-tone" keyboard presents three alphabetic characters per key, using the single keystroke entry contemplated by the present invention results in an inherently ambiguous key code. Thus, the dual tones for each key depression presents an ambiguous series of tones to the receiver. However, as with the word "HELP," it was found that over 96% of the most commonly used words could be identified by the word codes generated.

Therefore, in a broad sense, the apparatus 10 could incorporate a stored vocabulary of word codes and the corresponding ASCII representation for each word in a memory look-up table. When a sequence of word codes is entered followed by an "*", a search could be initiated in memory which points to the correct ASCII characters to be displayed. In practice, storing complete

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word codes and ASCII representations in memory was found to limit word recognition capability to the stored word vocabulary, and even then, large memory size was necessary.

In the preferred embodiment, "syllabic elements" are stored in memory and combined to create the words. For example, the "CON" letter group in contest, silicon, conference, contact, etc. is such a stored syllabic element. Thus, the vocabulary stored in the preferred embodiment includes common letter-groups, suffixes, prefixes, single letters, and a few complete words, generically referred to as "syllabic elements." In the preferred embodiment, it was found most efficient to include several letter strings which provide and enhance word recognition capability; therefore the vocabulary of syllabic elements in the preferred embodiment includes elements having one alphabetic letter to as many as nine alphabetic letters. Most syllabic elements have a three to six letter group size.

To further reduce memory size, the preferred embodiment enclosed incorporates an ASCII mapping table illustrated schematically in FIG. 4. That is, instead of allocating memory for the ASCII representation for each syllabic element, the ASCII representation is developed from the mapping table.

In use, the receiving individual must attach the conductive pick-up 26 to the ear portion of the hand piece 16 (see FIG. 1). The sending individual simply enters the desired alphabetic letters of the desired message on the touch-tone telephone 12 sequentially. The asterisk key "*" is used as a space to separate words. The number key "#" is used before or after any information that should be interpreted as numeric information. Of course, the sender cannot use abbreviations. The apparatus 10 responds in real time, beginning the recognition process as soon as the space key is received. The text of the message is displayed on the LCD display 50 from the lower left position to the right. When the lower row is filled the entire row is scrolled upward to allow new text to appear in the lower row.

As can be seen from FIG. 3, the series of tones constituting each word are decoded into a binary code. In the preferred embodiment each key depression represents a "key code" indicative of the key depressed. Two key codes are entered per byte, thus, the first byte contains the four bit binary code representation of the first two key codes of a word. The word code comprises a series of key codes entered between the asterisk "*", and in the preferred embodiment can occupy up to 7 bytes, accommodating word sizes up to fourteen characters. If the word has an odd number of characters, and therefore an odd number of key codes, the last key code is stored in the high order four bits of the last byte and the low order bits are set to zero.

The microcomputer 40 (FIG. 3) reads the four bit binary code upon receiving a latch signal from the tone decoder 34. The program (FIGS. 5-8) and stored syllabic element vocabulary are fetched from ROM 42. The word recognition process is initiated as soon as an entire word code is received (as indicated by the asterisk input).

Turning to FIG. 4, the recognition search is initiated in the segmented look-up table that contains the key codes in the four bit format for the syllabic element vocabulary. The look-up table is segmented according to syllabic element size with the size of the word to be decoded determining the point of entry into the look-up table. In the preferred embodiment, there are nine seg-

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ments in the look-up table corresponding to syllabic elements ranging from one to nine characters in size. For words having more than nine characters, the search is initiated in the ninth segment and a new word code corresponding to the first nine keystrokes (key codes) of the word is formed (see also FIG. 6). Of course, the size of the syllabic element is known upon entry into a given segment, therefore the number of bytes required to store the key codes for each of the syllabic elements will also be known.

Although the word code typically occupies more than one byte, only the first byte is checked for a match initially. The other bytes are checked only when a match occurs for all the previous bytes for the given syllabic element. If no match is detected, the search proceeds to the next syllabic element in the segment of the table. If no match is found in the segment of the table for the syllabic element size equal to the size of the word, the search is continued in the segment of the next lower size. That is, the word code is recomputed to exclude the last received key code for later use in the recognition process. This procedure is repeated until a match occurs. At the latest, a match will occur upon entering the single character segment of the look-up table.

After the first syllabic element is identified, the search is repeated using a reduced word code. The reduced word code comprises the original word code less the first N characters, where N is the size of the first syllabic element identified. This cycle is repeated until the complete word is identified. Most words are identified by connected syllabic elements 2 to 4 characters in size. However, there are a limited number of large syllabic elements of 5 to 9 characters which are used to identify words that are difficult to separate into unambiguous short syllabic elements.

Some syllabic elements have the same word code and therefore can have multiple interpretations. Such multiple meaning syllabic elements are specially flagged in the look-up table and stored in a way that the most frequently occurring interpretation is decoded first. If the element displayed on the LCD display 50 does not make sense to the reader, he can replace the string with the alternate interpretation by pressing a retry button (such as the operator or "O" key). Of course, in many cases the user can interpret such alternative interpretations from the context of the other syllabic elements forming the word or other words in the message.

Although the display could be generated by storing a pointer to the proper ASCII string representing each syllabic element in the look-up table, the preferred embodiment utilizes an indirect referencing technique. As illustrated in FIG. 4, an ASCII mapping table is utilized to identify the proper ASCII string for the syllabic element recognized in the look-up table. The first input to the ASCII mapping table is the key code which is known and limits the possible choices for the alphabetic character to a maximum of three.

The second pointer to the ASCII mapping table is generated to correspond with the position of the alphabetic character on the particular key depressed. To this end, a series of letter position mapping codes (LPMC) bytes are formulated for each word code. Each LPMC byte contains four 2-bit letter position codes (LPC). Each LPC can take the value of either 1, 2, or 3 depending upon the letter position on the key. As can be seen from FIG. 4, the binary representation of the letter position is used to enter the ASCII mapping table, 01

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for the first letter positioning, 10 for the second letter positioning and 11 for the third letter positioning. Thus, the key code (KC) and letter position code (LPC) act as column and row pointers into the ASCII mapping table to find the proper ASCII code for the character. The ASCII code is fetched and moved to an output buffer. This method requires only 27 bytes of ASCII character storage as each possible character is stored only once, and an additional 8 bits per 4 characters to store the letter position codes (LPC).

FIG. 4 illustrates the recognition process for the word "HELP". The word code, "4357" is passed to the four character segment of the look-up table. As previously discussed, the microcomputer 40 begins the search process until a match is formed. The matched word code points to a letter position mapping code (LPMC) byte. As illustrated in FIG. 4, the first letter position code (LPC) in the letter positioning mapping code (LPMC) byte has the binary code (10) for "2" which is the letter position of "H" on the number "4" key. The LPC is used as the column pointer in the ASCII mapping table with the key code used as the row pointer to identify the letter "H".

In practice, the apparatus 10 recognizes the entered words as fast as the words can be entered by the sender. Thus, the apparatus 10 is real time, displaying the decoded word on the LCD display 50 less than 1 second after the asterisk key is depressed. A prime advantage of the method and apparatus 10 is that single character entry is sufficient for communication. This represents a significant advance as a communication aid for the handicapped.

Of course, the apparatus 10 hereof is equally adaptable for use in many other situations. For example, with a paging system where space is limited, a small number of keys could be incorporated to efficiently send a message using the single character entry recognition of the present invention.

Although the present invention contemplates that the sender will simply use a standard touch-tone telephone and the receiver will utilize the apparatus 10, roles could be reversed. The apparatus 10 can be used as a sending device which incorporates a speech synthesizer. That is, the sender would couple the device 10 to the mouth section of hand piece 16 of the sending telephone 12 and generate the message on the key pad 18. Apparatus 10 would generate synthetic speech audibly conveyed to the receiving telephone 14.

Still another alternative would be to use the apparatus 10 of the present invention for remote computer control by non-handicapped individuals. For example, using the single character entry, words like PRINT, LIST, SAVE could be easily recognized and the output controlled. If fact, better results and an expanded vocabulary can be obtained if the characters on the standard telephone key pad 18 are distributed differently. That is, the sender could use an overlay with optimum character distribution to send his message. While this approach may be feasible for remote computer use, simplicity considerations for the handicapped dictate using the standard key pad 18 with suboptimum character distribution.

The apparatus 10 could also be used for consumers to enter orders to a vendor's computer. Many variations exist; the apparatus 10 enabling the entry of messages easily into a computer or practically any message receiver.

We claim:

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1. A communications apparatus comprising:
receiving means operably connectable to a telephone or the like for receiving a series of transmitted tones corresponding to an input word and for decoding the tones into a series of codes, each tone being representative of a letter of the word, which letter is one of two or more alphabetic characters corresponding to the tone;

controller means coupled to said receiving means for processing said series of codes and outputting a signal indicative of a particular word which corresponds to said series of codes, said controller means including, recognition means for matching said series of codes with a programmed code sequence indicative of said particular word,

said recognition means including a stored vocabulary comprising a plurality of syllabic elements, each being representative of one or more alphabetic characters, said recognition means being operable for matching said series of codes with one or more syllabic elements and outputting a signal indicative of a particular word represented by said one or more syllabic elements; and

indicating means for receiving said signal and communicating the signal in a form perceptible to the user.

2. The apparatus according to claim 1, wherein said receiving means includes an inductive pickup coupleable to the ear piece of a telephone receiver.

3. The apparatus according to claim 1, wherein said receiving means includes an amplifier section for receiving and amplifying said tones.

4. The apparatus according to claim 1, wherein said receiving means includes a tone-decoder for decoding the tones into a binary code.

5. The apparatus according to claim 1, wherein said indicating means includes a visual display for communicating said particular word.

6. The apparatus according to claim 5, wherein said indicating means comprises a liquid crystal display module.

7. The apparatus according to claim 1, wherein said receiving means is operable for receiving tones indicative of numeric characters, said controller means is operable for receiving and processing said numeric-representative tones and outputting a numeric-representative signal, and said indicating means being operable for displaying said numeric-representative signal.

8. The apparatus according to claim 1, said recognition means including mapping means operably coupled to said receiving means and operable for identifying the two or more alphabetic characters represented by a discrete tone.

9. The apparatus according to claim 8, said mapping means operable for utilizing said programmed code sequence and said identified two or more alphabetic characters for generating an ASCII code representative of each character of said particular word, said plurality of ASCII codes generated being output from said controller means as a portion of said signal.

10. A method of communicating, utilizing a signal-generating keyboard where at least some of the keys represent two or more alphabetic characters, comprising the steps of:

inputting a word into said keyboard by depressing a single key for each alphabetic character of said word;

transmitting signals generated by the key depressions;

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receiving said transmitted signals and decoding the signals into binary code;
 matching said binary code with one or more pre-programmed codes, each pre-programmed code being representative of a syllabic element;

Forming a representation of the word from the one or more syllabic elements represented by the matched one or more pre-programmed codes; and
 outputting the word representation in a form perceptible to the user.

11. The method of claim 10, wherein the outputting step includes displaying said word in a visually perceptible form.

12. The method of claim 10, wherein the signal generated by the keyboard is a dual tone multiple frequency and the keyboard comprises a touch-tone telephone.

13. The method according to claim 10, wherein each pre-programmed code of the syllabic elements corresponds to the key depressed and the position of the character of the syllabic element on that key including the steps of:

providing an ASCII mapping table presenting the ASCII strings corresponding to respective alphabetic characters;

identifying the ASCII string for each character of each matched syllabic element by

entering the mapping table with reference to the key depressed on the keyboard for each character of the matched one or more syllabic elements,

cross-referencing the position of the character on said depressed key to determine the discrete ASCII string for the alphabetic character; and

outputting the ASCII string for each character of each syllabic element to an output buffer.

14. A method of recognizing an input word from an input series of codes in which each input code represents one letter of the word which letter is one of two or

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more letters that the code corresponds with, comprising the steps of:

establishing a limited vocabulary of syllabic elements representing one or more letters and comprising one or more codes in a lookup table, in which said word is not represented by a single syllabic element in the lookup table,

the lookup table being separated into segments according to the number of letters of the syllabic elements;

matching the series of codes to two or more syllabic elements comprising the substeps of considering two or more successive codes of said word as a group,

entering the lookup table in the segment corresponding to the number of codes in said group,

comparing said group of codes with the codes of each syllabic element in said segment until a match is found, or if no match is found, decrementing the number of codes in the group, entering the lookup table in another segment corresponding to the number of codes in said decremented group, and comparing the decremented group of codes with codes of each syllabic element in said another segment until a match is found, or if no match is found, successively decrementing the number of codes in the group and comparing the decremented group of codes with the codes of each syllabic element in another segment until a match is found, and

considering the remaining unmatched codes in said word as one or more additional groups and repeating the entering and comparing steps using each additional group until all of the syllabic elements of the word are identified; and

outputting the two or more matched syllabic elements as said word.

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